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VOLUME I

EXECUTIVE SUMMARY

NASA REPORT NO. CR 168150

CUSTOMER PREMISES SERVICES MARKET DEMAND ASSESSMENT

1980 - 2000

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VOLUME I
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16. Abstract This report provides estimates of market demand for domestic civilian telecommunications services for the years 1980 to 2000. It covers overall demand, demand for satellite services, demand for satellite delivered Customer Premises Service (CPS), and demand for 30/20 GHz Customer Premises Services. Emphasis is placed on the CPS market and demand is segmented by market, by service, by user class and by geographic region. Prices for competing services are discussed and the distribution of traffic with respect to distance is estimated. The report also provides a nationwide traffic distribution model for CPS in terms of demand for CPS traffic and earth stations for each of the major SMSAs in the United States.			
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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

This report summarizes a study of market demand for Customer Premises Services provided via communications satellites. The work leading to this report was performed under NASA Contract NAS3-22893 during 1982 and early 1983. It is related to earlier market studies which deal primarily with demand for trunking services [Ref. 1 and 2]. The report consists of the present summary volume (Volume 1) and the separately bound Volume 2, which contains the main body of the report.

1.0 INTRODUCTION

1.1 PURPOSE

The earlier studies referred to above forecast an expansion in telecommunications demand, over the next two decades, for both conventional and advanced communications services. The present study emphasizes that portion of the demand that can be addressed by satellite systems delivering services directly to the customer.

The results of the study are intended to support systems design efforts, and to permit the timely development of the satellite technology that will be required to satisfy emerging demand.

1.2 DEFINITION OF CUSTOMER PREMISES SERVICE

Customer Premises Service (CPS), as used in this report, refers to satellite telecommunications delivered to earth stations located on the premises of individual customers (dedicated earth station installations), or to earth stations shared by several nearby customers (shared earth station installations). In either case, it is intended that the satellite links terminate as directly as possible at the end user's location so that local distribution via common carrier is not needed for the main volume of traffic.

In most cases, however, some interface with common carrier facilities will be desired for part of the CPS traffic. Links between the earth station and the local telephone exchange will usually be needed to accommodate the off-net requirements of incoming calls. Similarly, the ability to transmit calls from an originating CPS earth station to remote earth stations, maintained by common carriers, and allowing common access to trunking facilities, will be desired by many CPS users. Such enhancements are within the province of CPS, and their use is contemplated in the forecasts and projections developed in this document.

1.3 DEFINITION OF ADDRESSABLE TRAFFIC

This report provides estimates of addressable traffic. Traffic is addressable by a transmission medium if there are no economic or technical reasons which prevent, or strongly discourage, the use of the medium for that type of traffic. Other media may also compete for the addressable traffic so that the actual market share captured by a particular medium is, in general, less than the traffic that is addressable.

Since CPS facilities were not widely available in 1980, the estimates of CPS addressable demand made for 1980 refer to the traffic that, hypothetically, could have been addressed if suitable CPS systems had been available at that time.

1.4 SCOPE

The report covers the period 1980-2000, with benchmark years at 1980, 1985, 1990, and 2000. Market demand, in terms of both annual traffic and busy hour traffic, is estimated for the following markets:

1. The overall telecommunications market
2. The satellite addressable market
3. The CPS addressable market
 - a. Dedicated earth stations
 - b. Shared and dedicated earth stations
4. The Ka band CPS addressable market
 - a. Dedicated earth stations
 - b. Shared and dedicated earth stations

The overall telecommunications market deals with that traffic, addressable by terrestrial or satellite transmission

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media, that travels beyond local boundaries. Each of the remaining markets in the list above represents a subset of the preceding market.

The satellite addressable market is that fraction of the overall market for which transmission distances are high enough to make satellite transmission a cost competitive alternative to terrestrial transmission.

The CPS addressable market is differentiated from the more general satellite market by including only that fraction of demand which does not require very wide distribution, and which originates at establishments with traffic volumes high enough to justify an earth station.

The Ka band CPS market refers to traffic addressable by those CPS systems using higher frequency satellites. Under favorable climatic conditions, and with suitable system designs, it is possible for Ka band systems to deliver a level of reliability equal to that of most competing transmission systems. Under these circumstances the Ka band CPS market is essentially the same as the more general CPS market discussed in the preceding paragraph. In some implementations, however, Ka band systems will be subject to rain attenuation of the signal and will therefore provide lower levels of reliability. In this report the Ka band market refers to the latter case and the traffic estimates presented reflect the impact of lower reliability on the addressable market.

The early chapters of the report offer background discussions of the technology, user characteristics, and economic factors that enter into the market estimates developed in later chapters. Part of this material rests on secondary research in reports, trade journals, news releases, textbooks, tariffs and other documents. The documentary research was supplemented by a survey of users, designed to uncover additional information on which to base the market estimates. The survey comprised on-site and telephone interviews with 370 organizations selected as offering a representative cross-section of potential users of communications services.

The report develops basic demand estimates which cover the following service categories:

1. Voice- Switched
Dedicated
2. Video- Broadcast
Videoconferencing
3. Data - Message
Computer

Within each of these service categories more specific sub-categories are defined, and are discussed in the text.

The amount of traffic that travels substantial distances has an obvious bearing on the magnitude of the demand likely to develop for satellite derived communications in competition with terrestrial alternatives. The report presents distance distributions for each of the major categories of traffic.

The basic demand estimates for each market are segmented by year, service, geographic region, user class, and various combinations of these parameters. Extensive tabulations of these results are included. A nationwide traffic distribution model is also developed by further segmenting demand according to Standard Metropolitan Statistical Areas (SMSAs). Busy hour traffic demand is forecast for each of the top forty SMSAs, and for the remaining SMSAs in groups of twenty. This is supplemented by a matrix showing traffic patterns among the top forty SMSAs.

2.0 POTENTIAL CPS SERVICES

All of the conventional voice, video and data applications find their counterparts in the CPS environment but some applications are better suited than others. Some of the important advantages and limitations of CPS are discussed below.

2.1 VOICE

Voice communication is a major contributor to all of the markets examined in this study. For satellite transmissions, including those associated with CPS, problems of echo and time delay exist, but are correctable through the use of echo cancellers or similar devices. In the CPS environment, however, it is possible to supply, economically, four-wire service to the user. This avoids the four-wire to two-wire interface that is commonly used between the long haul and the local transmission plants. Since this interface is the primary cause of the unwanted echoes, CPS offers an alternative and attractive means of dealing with the problem.

CPS installations are restricted to those users with traffic volumes high enough to justify the cost of dedicated or shared earth stations. The CPS community is therefore a limited one and the ability to distribute CPS originated calls to a wide range of large and small users is, consequently, restricted. This is a serious disadvantage for dial-up voice users who traditionally expect to be able to access any of the millions of telephones in service. While this problem is less pronounced in dedicated voice applications, it tends to limit the ability of CPS to address these as well as the switched applications. System configurations which enhance the connectivity of CPS will, therefore, increase the CPS share of voice traffic.

The connectivity and distribution capabilities of CPS can be enhanced by several methods, two of which are illustrated in Figures 1 and 2. The establishment of off-net service by means of links between CPS earth stations and nearby telephone central offices, as illustrated in Figure 1, is one

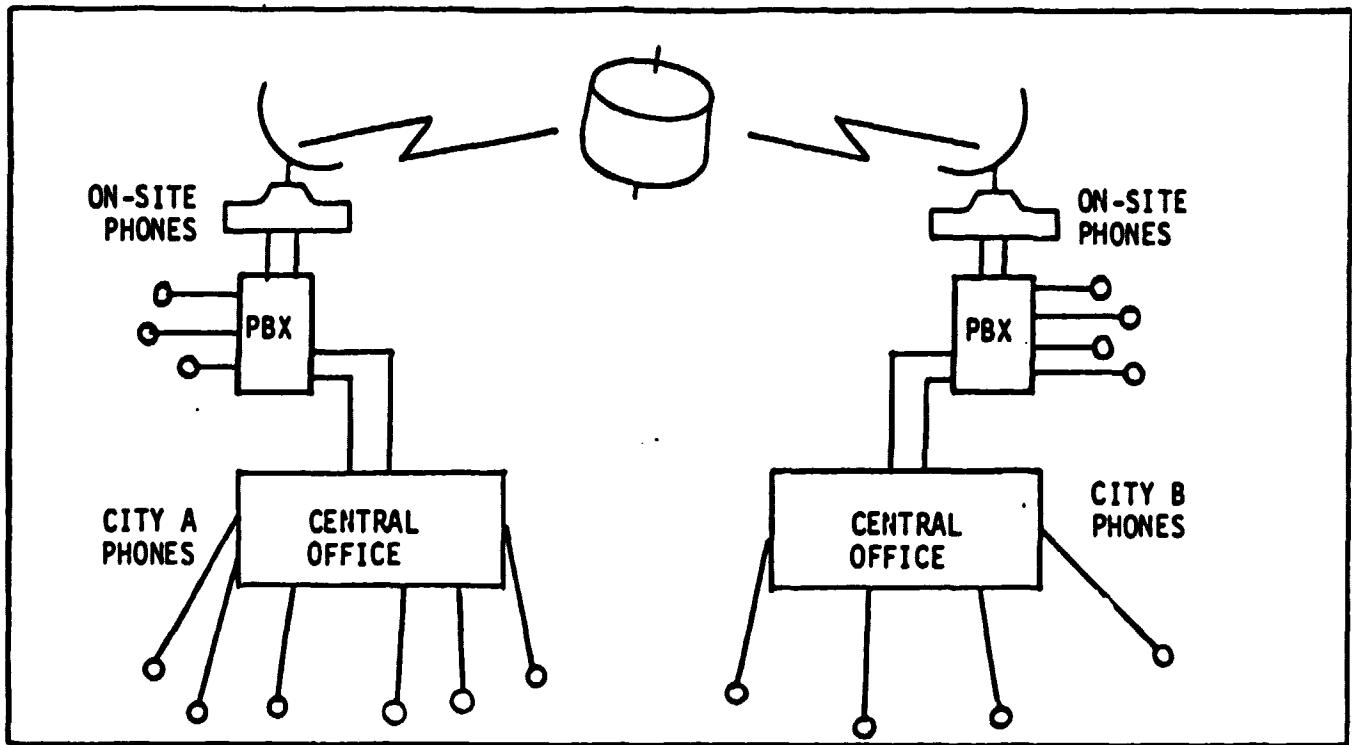


FIGURE 1. OFF-NET SERVICE

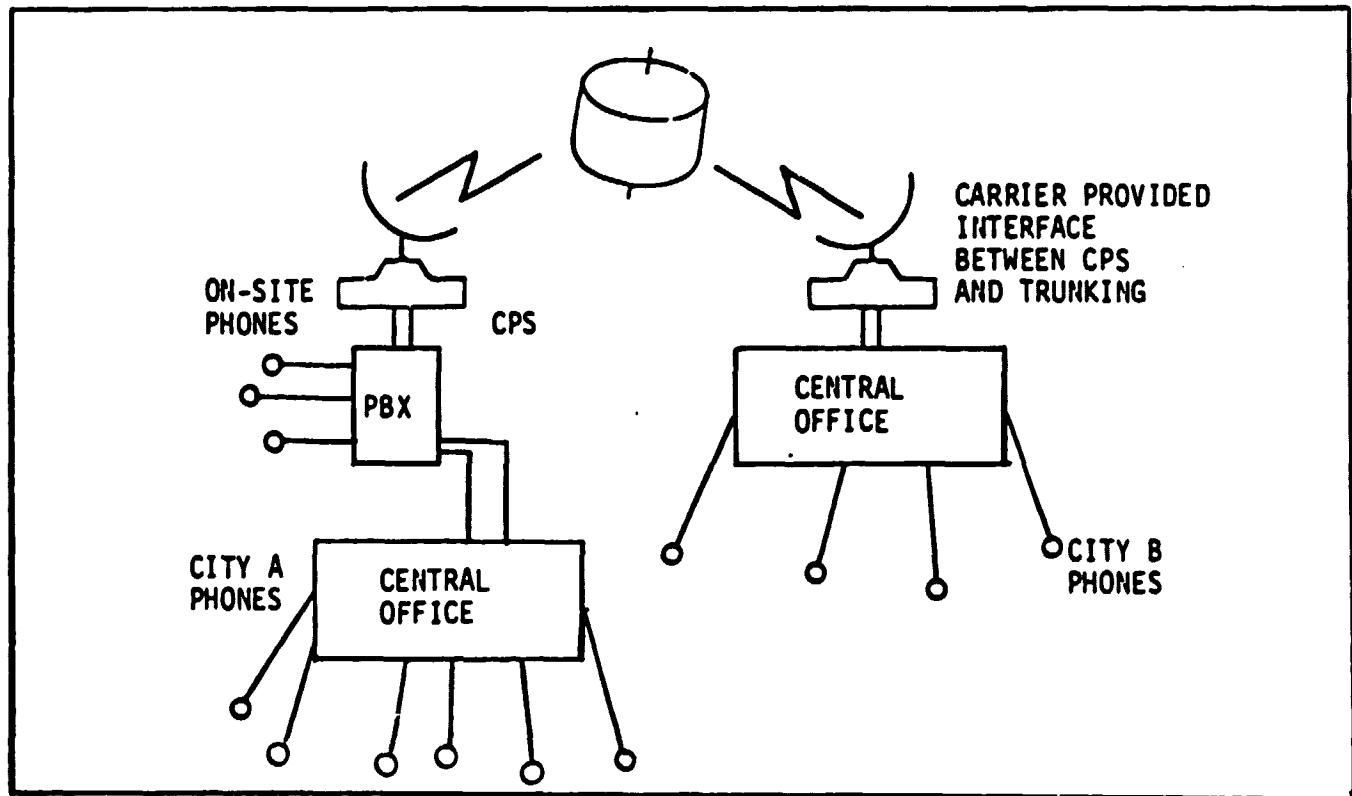


FIGURE 2. COMMON CARRIER INTERFACE BETWEEN CPS AND TRUNKING

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with wide applicability. CPS users can use the off-net links of a distant CPS earth station to complete calls, via trunking, to non-CPS equipped users in the vicinity of the distant earth station.

Connectivity for CPS voice users can also be enhanced by placing earth stations, operated by common carriers, at selected locations to serve as additional interfaces between CPS and trunking. Figure 2 illustrates this arrangement. Distant CPS users, who do not maintain CPS facilities in the localities served by the common carrier earth stations, can address these earth stations to reach otherwise inaccessible destinations.

These, and other methods of broadening the distribution and connectivity available to CPS users, will be important in allowing the use of CPS in many voice applications. The development of the technology that permits this should, therefore, be encouraged. The market estimates presented in this report assume that such technology will be available as needed.

It is likely that the technology employed by future CPS systems will favor digital transmission. Many devices have been developed for the digitization of voice signals with output rates for a one-way transmission ranging from 2400 bits per second or less to 64,000 bits per second. As a general rule, cost and voice quality are inversely related to the digitization rate but, of course, the higher rates demand higher throughputs and wider bandwidths. While some satellite common carriers have adopted a 32 Kbps voiceband rate, the terrestrial de facto standard is likely to remain at the one-way 64 Kbps rate widely used in the T1 carrier system.

Use of the 64 Kbps rate for CPS voice channels will facilitate the interconnection of CPS with terrestrial facilities, and will also assure the maintenance of satisfactory voice quality when CPS voice signals are extended through additional terrestrial relays. The assumption underlying the market estimates of this report is, therefore, that voice signals will be digitized at a 64 Kbps rate for transmission over CPS. It is recognized, however, that lower digitization rates may become more attractive if the spectrum resources set aside for CPS transmissions become scarce, or if cost tradeoffs between bandwidth and digitizing equipment begin to favor the more expensive, high compression, approaches.

2.2 VIDEO

Video traffic demand in this report is discussed under two major headings:

- a. Videoconferencing, which refers to two-way interactive video and audio communications.
- b. Broadcast, which refers to one-way transmissions from a single originator to many receive only locations.

Videoconferencing provides a good target for CPS systems provided that costs can be kept competitive with travel costs. For many videoconferencing applications limited distribution is satisfactory and, where necessary, the signals can be extended through wideband terrestrial links. The traffic demand estimates presented in this report assume that bandwidth compression equipment is used to reduce the bit rates needed for videoconferencing channels. The use of one or two T1 channels (at 1.455 Mbps each) appears to provide an acceptable compromise between satisfactory picture quality and link capacity.

The broadcast mode video transmissions include network TV, CATV, and various applications in health care, public affairs, and education, including remotely conducted seminars and presentations. Return channels, if any, for these transmissions are generally conventional voiceband channels used for questions and comments from the audience. While included with respect to the overall and the satellite markets, these one-way video broadcasts are not likely to be compatible with the two-way transmission capabilities associated with CPS designs of the type considered here. Broadcast mode video is, therefore, not included as a significant contributor to CPS traffic.

2.3 DATA

Most data applications use voiceband lines and many of the considerations applicable to voice apply also to data. The need for wide distribution, for example, is a requirement of many data applications. However, a greater portion of data transmission uses dedicated facilities and, as a result, the limited distribution capabilities of CPS are less restricting for data than for voice.

The time delay of satellite links is a potential problem for data. Many of the current data communication protocols become inefficient when delays are large. The immediate solution, in these cases, is the installation of delay compensation hardware in the earth stations but, in the long term, an evolution to newer, delay tolerant, protocols will eliminate the need for this hardware.

Depending on the mode used for handling the data signal, the digital transmission links envisioned for CPS may result in either high, or very low, efficiencies. Packet modes, for example, are well suited to data transmissions and make efficient use of capacity. On the other hand, most of the commonly used methods of data transmission inefficiently use a full voiceband channel, even for data signals operating at much lower rates. The problem is compounded when the applications involve real time interaction with human operators whose limited typing and reading speeds result in long idle periods on the line. When the various modes of data transmission are combined in proportion to their expected usage, the low efficiency applications dominate, and average line efficiencies of less than one percent are expected to prevail over the time frame of this study.

Most data transmission takes place over voiceband channels but wideband data links are of growing importance and are expected to account for substantial demand as suitable facilities become widely available. The ability of CPS to avoid the difficulties of wideband local distribution is a positive factor in addressing this market.

The proliferation of microcomputers promises to have an important influence on business methods and life styles. The impact on CPS data traffic, however, is not likely to be intense because most of the applications will require wide distribution and because a large portion of the traffic will involve homes and small businesses not readily addressed by CPS.

3.0 POTENTIAL CPS USER CLASSES

The study considers four user classes under the headings of Business, Government, Institutions and Residential. Suitable subclasses are introduced where needed. Each class is discussed below with emphasis on factors favorable to, or opposing, the use of CPS.

3.1 BUSINESS

Business users account for the largest volume of telecommunications demand. Circa 1980 expenditures among large business users were approximately 70 percent for voice, 27 percent for data, and 3 percent for video and other wideband services.

While both intrastate and interstate markets are addressable by CPS, the longer distances, characteristic of the interstate market, are better suited to CPS (and other satellite based) approaches. The division of expenditures among large business users is roughly 54 percent for interstate service as compared to 46 percent for intrastate.

Switched applications need wide distribution and are consequently less attractive targets for CPS than are applications using dedicated communications. Recent expenditures by large business users of interstate communications have been in the ratio of 55 percent for switched service versus 45 percent for dedicated.

Recent trends toward the increased use of non-telco services offer a positive indication of the acceptability of new and innovative services such as CPS. Large business users spent 10.6 percent of their budgets on non-telco services in 1978 and anticipated substantial growth in this percentage during the next decade.

3.2 GOVERNMENT

Federal civil employment accounts for 2.8 percent of total U.S. employment and demand for long distance communications from this sector exceeds this percentage. Some of the major federal systems offer important targets for CPS. The Federal Telecommunications System (FTS), one of the world's largest private line networks, is an excellent example. The FTS is nationwide in extent and contains approximately 35,000 inter-city voiceband lines. A possible prime target for CPS is the backbone network of about 12,000 two-way voiceband trunks linking some 54 switching centers, which provide logical locations for earth stations. Between 10 and 20 percent of the interswitch trunks are presently supplied by satellites, and the emphasis on satellite transmission has been increasing.

The postal system also offers enormous potential for CPS participation. The recently introduced Electronic Computer Originated Mail (E-COM) service, which has 25 serving post offices throughout the nation, is only a first step in the application of telecommunications technology to mail delivery. First class mail, with its requirements for nationwide, high volume delivery service to major population centers, appears ideal for CPS. Most mail can tolerate delays ranging from hours to days so that the higher frequency satellite transmission bands can be used without too much concern over possible weather induced outages.

State governments are also heavy users of telecommunications, but the more limited geographic dispersion of most state communications is less favorable to CPS. Nevertheless, potential uses exist and add to the CPS addressable market. The key to this market appears to be cost competitiveness. To the extent that CPS systems can offer favorable rates, over the shorter distances used in state communications, a smaller, but significant, market can be addressed.

3.3 INSTITUTIONS

Institutions that are potential contributors to CPS demand generally fall in the educational or health care fields. Each of these is discussed below.

There are about 2800 institutions of higher education in the United States with expenditures in 1980 totaling 2.24 percent of the gross national product. Advanced uses of telecommunications are readily accepted in this environment, and applications using special computer networks and teleconferencing are frequently encountered. The relatively short distances involved, however, tend to discourage the use of CPS. While nine percent of the colleges and universities have branch campuses some distance from the main campus, the entire complex is generally confined within the boundaries of a particular state. CPS installations are, therefore, more likely to be motivated by requirements for advanced wideband transmission, than by strictly economic tradeoffs.

Health care is also a major area of economic activity. There are about 7000 hospitals in the United States and expenditures in 1980 were 9.4 percent of the gross national product. Massive amounts of data accompany these activities but most of this remains in the local area. As computers take a more dominant role, however, the emergence of nationwide data networks is a possibility. While many advanced uses of telecommunications are under consideration, most applications have focused on remote diagnosis using video links, and educational seminars for doctors, nurses, and other health industry personnel. Demand for CPS will be found among these activities, but the overall volume is expected to be small.

3.4 RESIDENTIAL

Many signs point to the rapid growth of advanced telecommunications in home applications. The role of CPS satellite transmissions in this environment, however, is less clear.

Direct broadcast of television signals to home roof-top antennas is not far off, but the special one-way broadcast satellite systems designed for this purpose are not likely to be compatible with the two-way CPS systems that are the subject of this report.

Other emerging residential applications are related to the proliferation of home terminals with their ability to extend shopping, banking, information and message services to the home. Despite the growing public awareness of these new services, the impact on CPS demand is likely to be slight. In most cases the transmissions will be local, and individual users will not generate sufficient traffic to make an earth

station installation practical. Where demand for CPS does emerge it will require the mediation of a service provider to concentrate and consolidate traffic to volumes suitable for CPS transmission. Such uses, where anticipated, are included under the projections for business applications.

4.0 PRIMARY RESEARCH SURVEY

To supplement the data base obtained from documentary sources a survey of communications customers was conducted using questionnaires developed for the purpose. During the survey, which was completed in mid 1982, some 308 "users of communications services" were interviewed. An additional 62 respondents, who were classified as "providers of communications services", were also contacted. About ten percent of the interviews took place at the respondents' establishments. The remaining interviews were conducted by telephone.

The survey collected data on present and projected uses of telecommunications with the goal of arriving at volume of traffic estimates that could be related to other independent user population parameters. The most important information of this type was the relationship between numbers of employees and the usage of the various classes of telecommunications services.

The survey also developed supporting information on telecommunications budgets, geographic distribution patterns, applications in use or projected, sensitivity to cost and reliability, and any special factors which might influence the acceptability of CPS. Results appear as a series of tables with explanatory text. These results were used in arriving at the basic traffic estimates developed in this report, and also in segmenting traffic according to user class and service category.

Among other general conclusions it was clear from the responses to the survey that price is the key to user acceptance of CPS. CPS is of interest only as it provides cost advantages, and generally not for any other user-recognized reason, including bandwidth, digital operation, or other technical features.

The level of reliability (availability) provided is an important issue to most users. However, most of the respondents consider the availability of conventional communications services adequate and few would pay more than a small premium for an improvement. However, some tradeoffs between cost and availability in the downward direction would be considered by many respondents. Over half stated that they would settle for

lower availability if the costs were set low enough (i.e., at less than half of the present costs).

Data transmission applications for CPS are predominant in the thinking of the users interviewed. Video applications appear to be too new to have any significant place in either the present operations, or future plans, of most organizations.

Apart from the level of usage, which varies from one user class to another, there was little differentiation among user classes with respect to any of the issues explored. Similarly, geographic location of the respondent had little influence on the nature of the responses received.

5.0 COMPARATIVE ECONOMICS

As indicated by the responses received in the user survey cited above, pricing of service will be very significant in determining the acceptability of CPS. Tariff information was, therefore, compiled for a number of the more important common carrier service offerings, and serves as a useful guide for potential CPS pricings.

Voiceband private line prices are perhaps the best guide to comparative transmission costs. These circuits are very commonly available, are offered competitively by many terrestrial and satellite common carriers, and do not intermix the charges for transmission with other charges, such as those for switching. Typical voiceband private line prices are illustrated in Figure 3.

As may be noted from Figure 3, the price of terrestrial two-way voiceband private lines is distance sensitive. The price of satellite derived lines is also distance sensitive, but to a much smaller extent. There is, as a result, a cost cross-over, in the vicinity of 800 miles, above which satellite prices are generally lower than terrestrial prices. Other factors being equal, 800 miles can, therefore, be taken as the current boundary above which satellite services should find high acceptance. The report uses this boundary, together with traffic distance distributions, to develop estimates of satellite addressable traffic. The report also makes the assumption that, as satellite technology advances, the cost competitive distance for satellite transmission will gradually be lowered.

Videoconferencing services are a potential target for CPS. Comparisons between the cost of current videoconferencing services and the cost of travel, however, are not favorable to widespread use of videoconferencing. Depending on the travel charges included, from two to four employees can fly to their destination, attend one or more meetings, and return the next day at approximately the cost of a one hour videoconference. A desirable goal for CPS systems would be to deliver videoconferencing capabilities at a fraction of travel costs. The ability to use existing CPS facilities for videoconferencing on a secondary basis, during periods when the traffic volume of the primary applications is low, may assist in this respect.

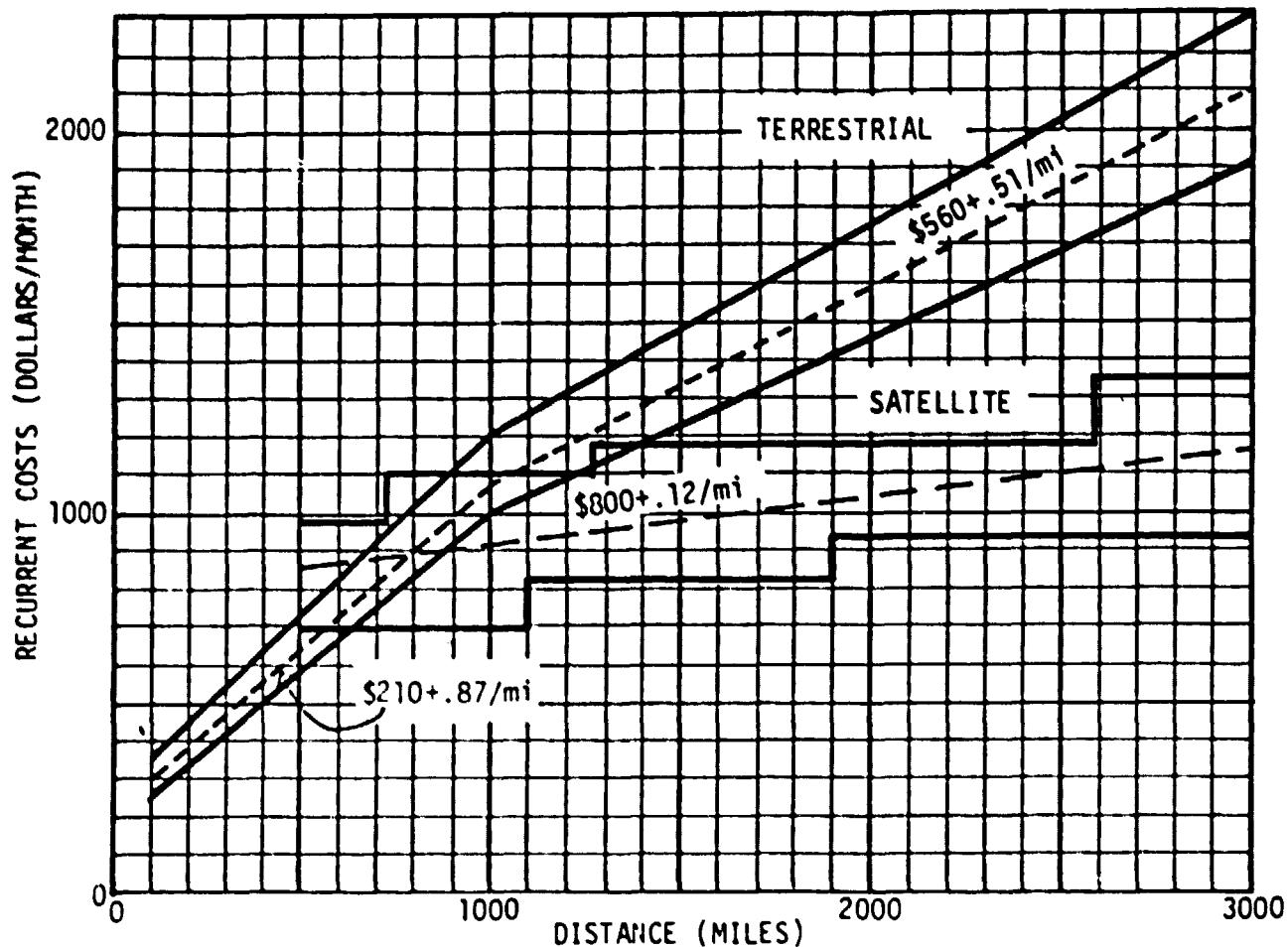


FIGURE 3. TYPICAL PRICES OF SATELLITE AND TERRESTRIAL VOICEBAND PRIVATE LINE SERVICE. SINGLE CHANNEL MONTH-BY-MONTH LEASE.

Future price trends for telecommunications are difficult to quantify but in fixed value dollars, the cost of communications has been declining for many years. Relative to the Consumer Price Index, the long distance Telephone Price Index (computed and published annually by the Bell System) has been declining at an average rate of 4.31 percent over the last two decades. These trends are illustrated in Figure 4. If these long term trends continue to the year 2000, the price of long distance service would, in constant dollars, be only 44.5 percent of the comparable price circa 1980.

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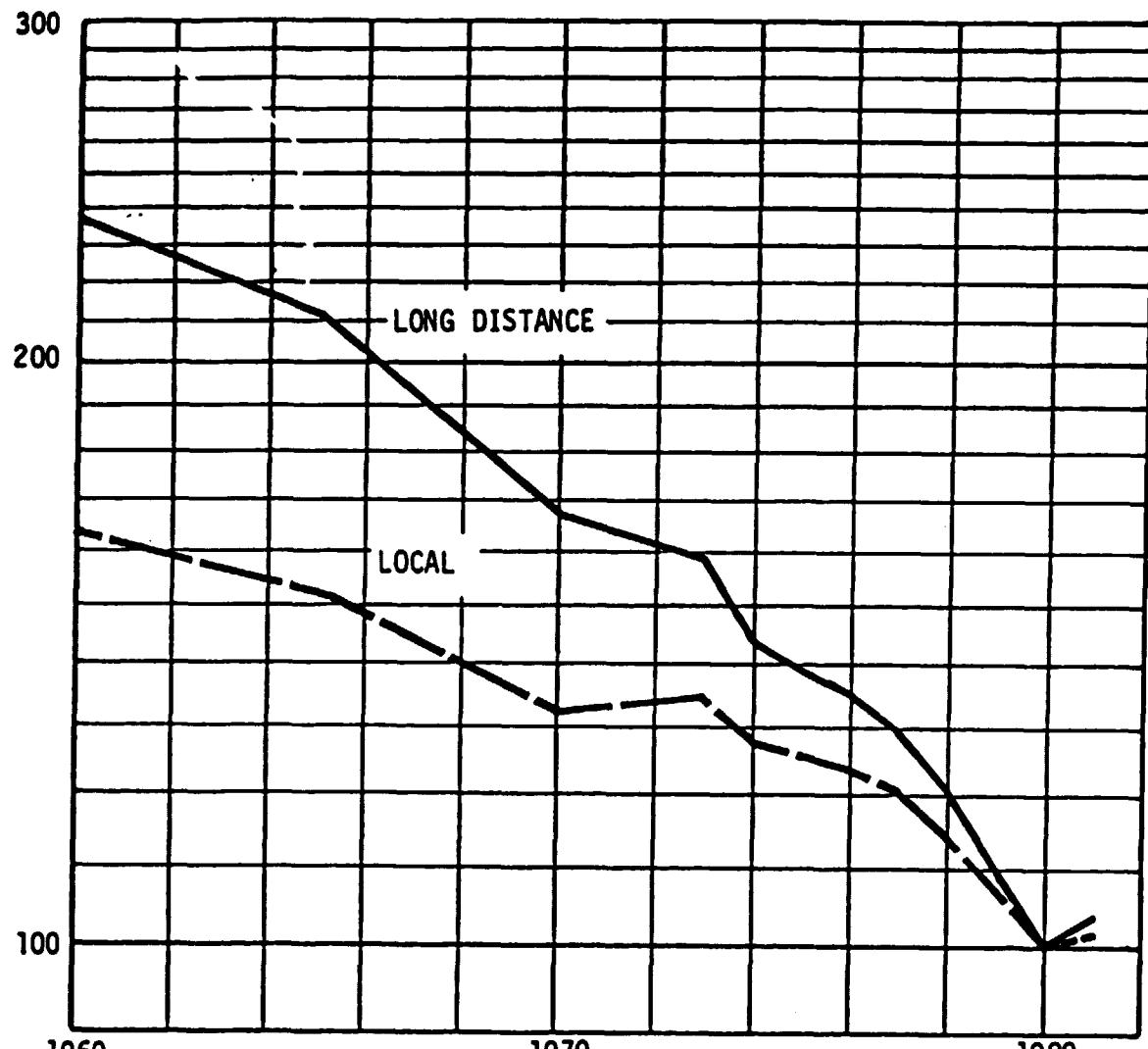


FIGURE 4. TELEPHONE RATE INDEXES RELATIVE TO CONSUMER PRICE INDEX
(BASE YEAR 1980)

6.0 MARKET DEMAND FORECASTS

Estimates of annual and busy hour traffic demand were developed for the overall market, the satellite market, the CPS market, and the market for lower availability CPS services. The methodology used is summarized in Figure 5.

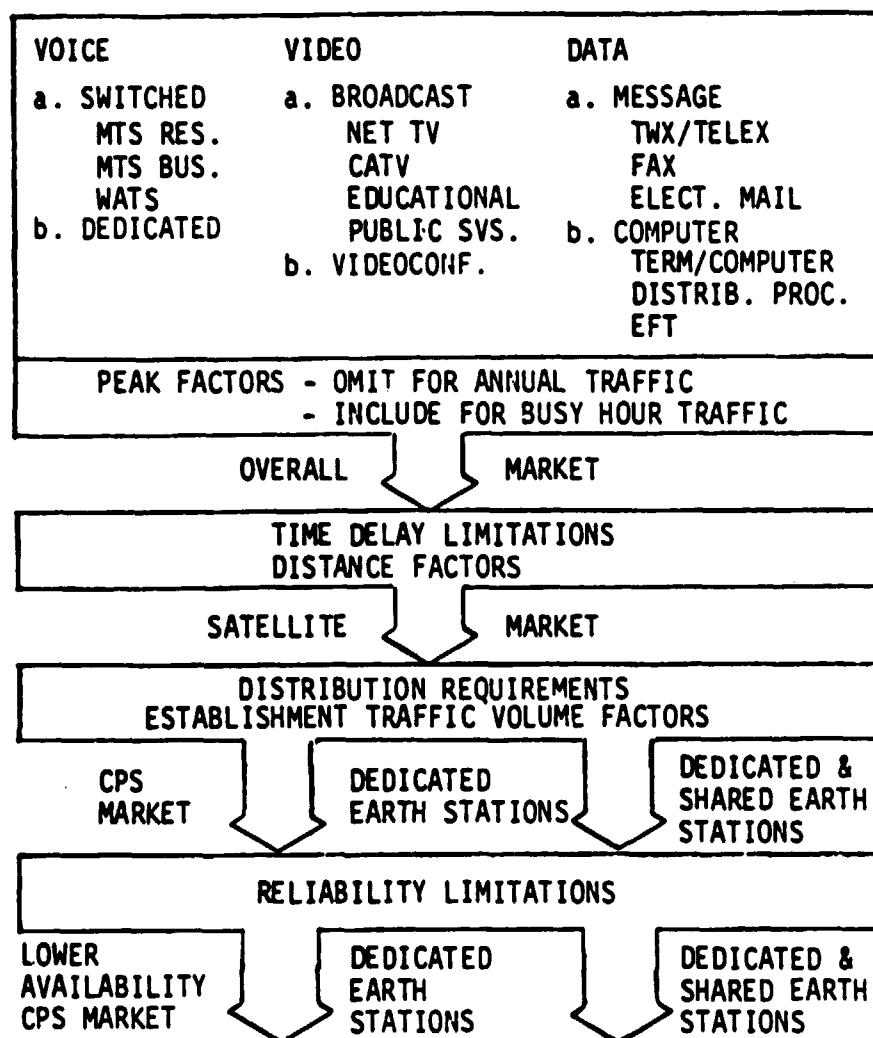


FIGURE 5. DEMAND FORECAST METHODOLOGY

As illustrated in Figure 5 the overall market (i.e., terrestrial and satellite traffic traveling beyond local boundaries) was analyzed first. The voice, video, and data service categories were each broken into the smaller subcategories shown at the top of the figure. Addressable demand was then estimated for each subcategory as a function of the benchmark years 1980, 1985, 1990 and 2000. Subcategory demands were then aggregated to arrive at various totals and subtotals.

In developing the market demand estimates a variety of techniques were used, as appropriate to the traffic subcategory being considered. Generally voice traffic estimates were based on the extrapolation of historical records showing the number of calls per year of various types. Video traffic estimates were formed by examining and extrapolating the number of broadcast channels in use and, in the case of videoconferencing, by estimating the displacement of a portion of business air travel. In the data category, demand estimates were based primarily on extrapolated terminal populations, and on the projected volumes of mail and checks. The same procedures were followed in estimating both annual and busy hour demand, which differ from each other only by the introduction of peak factors which depend on the traffic subcategory, and in some cases on the year.

As illustrated in Figure 5 each of the remaining markets was treated as a subset of the previous market. Thus, the satellite market was analyzed by selecting from the overall market that fraction of each traffic subcategory that is able to tolerate the time delays introduced by satellites, and which travels far enough to compete effectively with terrestrial media.

Similarly the demand for CPS was selected as that portion of the satellite market capable of accepting the limited distribution capabilities of CPS. A second important criterion for CPS is that the candidate establishments have sufficient traffic volume to justify the installation of a shared or dedicated earth station.

Lastly, the market estimates for lower availability service (typical of some Ka band CPS designs), were developed by selecting that portion of the CPS market able to tolerate lower levels of availability. Again, both dedicated, and shared plus dedicated, earth station markets were evaluated.

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Table 1 summarizes the addressable busy hour traffic for each of the markets analyzed. Results are presented as a function of the service category and the benchmark year. Voice, video and data traffic components are each expressed in terms of megabits per second. The use of this common unit of measure facilitates the comparison and summing of the traffic components and is consistent with the trend toward digital transmission facilities.

TABLE 1. ADDRESSABLE BUSY HOUR TRAFFIC
(THOUSANDS OF MEGABITS PER SECOND)

	VOICE	VIDEO	DATA	TOTAL
OVERALL MARKET				
1980	148.28	2.64	48.53	199.46
1985	242.80	3.70	90.11	336.12
1990	386.72	5.84	142.85	535.41
2000	855.14	13.86	333.15	1202.15
SATELLITE MARKET				
1980	16.21	2.64	3.17	22.02
1985	37.48	3.70	9.66	50.84
1990	84.45	5.84	27.07	117.36
2000	286.82	13.86	103.64	404.32
CPS MARKET (DEDICATED E.S.)				
1980	.38	.007	.22	.60
1985	.95	.004	.66	1.61
1990	3.63	.079	1.96	5.66
2000	17.34	.309	7.93	25.58
CPS MARKET (SHARED AND DEDICATED E.S.)				
1980	.94	.020	.53	1.49
1985	2.34	.010	1.62	3.97
1990	8.97	.196	4.83	13.99
2000	42.83	.763	19.59	63.19
LOWER AVAIL. CPS (DEDICATED E.S.)				
1980	.17	.004	.07	.25
1985	.43	.002	.22	.65
1990	1.63	.036	.67	2.34
2000	7.80	.140	2.71	10.65
LOWER AVAIL. CPS (SHARED AND DEDICATED E.S.)				
1980	.42	.009	.18	.61
1985	1.05	.005	.55	1.61
1990	4.04	.090	1.66	5.78
2000	19.28	.343	6.68	26.30

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The relative sizes of the various markets summarized in Table 1 are illustrated in Figure 6, which shows the busy hour traffic projected for the year 2000. In this chart the overall market is taken as a reference. Traffic which travels far enough to be addressable by satellites amounts to 34 percent of the overall market. The CPS market (including both dedicated and shared earth station installations) is limited by needs for wide distribution, and by the relatively high level of communications volume needed to justify an earth station, to about 15 percent of the satellite market (5.2 percent of the overall market). For those CPS designs that deliver lower levels of availability the addressable market is further reduced, and in the year 2000 is estimated to be 41.6 percent of the CPS market (2.2 percent of the overall market).

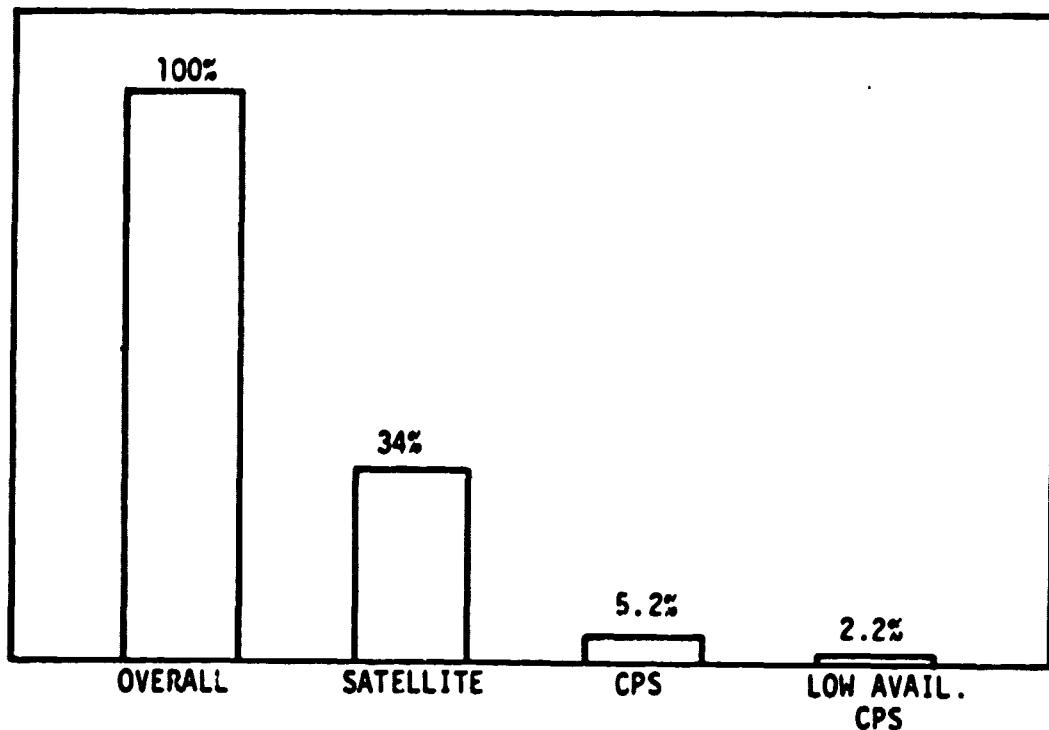


FIGURE 6. COMPARISON ON MARKET SIZES - YEAR 2000

While there is some variation from market to market in the relative importance of the different service categories, the variation is not large. For busy hour traffic in the year 2000, depending on the market, voice traffic accounts for 68 to 73 percent of addressable demand, data traffic accounts for 25 to 27 percent of addressable demand, and video traffic accounts for one to three percent.

In the voice category, dedicated voice (private line) and switched voice applications (MTS and WATS) are all significant contributors to demand. The fact that dedicated applications require full time reservation of communications capacity, even though the channel may be inactive for large portions of the day, magnifies the relative importance of these applications in the estimates of annual traffic demand. On the other hand, when busy hour traffic is considered, the switched voice components, because of their higher peak factors, receive extra emphasis.

The major contributors to demand for video services in the overall and satellite markets are the broadcast video components (primarily educational uses and CATV). Videoconferencing demand, though smaller than that of the broadcast video categories, is also of importance. The estimates for videoconferencing demand in this report, however, are lower than those offered in earlier studies, reflecting important recent advances in bandwidth compression technology. In the CPS market the broadcast video transmissions are excluded, leaving videoconferencing as the only significant contributor to demand.

Data traffic demand is chiefly the result of computer related traffic, the major subcategory of which is terminal to computer communications. This type of interactive traffic tends to make inefficient use of communications facilities and demand is consequently magnified. Message oriented data traffic, including electronic mail and facsimile, tends to use the facilities more efficiently and accounts for only about one percent of data traffic demand.

7.0 DISTANCE DISTRIBUTION OF TRAFFIC

The distribution of traffic with distance plays a key role in selecting that portion of traffic that travels far enough for satellite transmissions to be cost competitive with terrestrial media. This study assumes a gradual decrease in the cost competitive threshold distance, from the 800 mile distance characteristic of transmission costs circa 1980, to 600, 400 and 200 miles for the years 1985, 1990 and 2000. By comparing these threshold distances with the distance distribution of traffic, the study arrives at estimates of the amount of traffic addressable by satellites.

The distance distribution of traffic, as obtained from various published traffic studies, is presented for each of the major service subcategories. Composite distance distributions for each market are also developed by weighing the distributions of each service subcategory in accordance with its annual traffic volume. These composite distance distributions are shown in Table 2.

TABLE 2. FRACTION OF TRAFFIC TRAVELLING FURTHER THAN INDICATED DISTANCE

DIST. (mi.)	OVERALL MKT				SATELLITE MKT				CPS and Ka MKTS			
	1980	1985	1990	2000	1980	1985	1990	2000	1980	1985	1990	2000
100	.456	.459	.466	.477	1	1	1	1	1	1	1	1
200	.335	.338	.341	.349	1	1	1	1	1	1	1	1
400	.209	.211	.212	.214	1	1	1	.615	1	1	1	.577
600	.144	.145	.145	.146	1	1	.686	.418	1	1	.633	.368
800	.104	.104	.104	.104	1	.727	.494	.298	1	.660	.425	.248
1000	.076	.077	.075	.073	.740	.538	.358	.211	.644	.429	.280	.165
2000	.022	.023	.027	.023	.227	.161	.127	.066	.138	.094	.075	.045
3000	0	0	0	0	0	0	0	0	0	0	0	0

For the overall market, about 35 percent of the traffic leaving the local area is estimated to travel beyond 200 miles, about 21 percent travels more than 400 miles, 15 percent travels more than 600 miles and 10 percent travels more than 800 miles. For the satellite and CPS markets, demand is based on traffic components which exceed the cost competitive threshold distances. As a result, the composite distance distributions for these markets more heavily favor longer distance transmissions.

8.0 SEGMENTATION OF MARKET DEMAND

The market demand forecasts discussed above develop addressable traffic demand by market, by service, and by year. Further segmentation is also provided according to user class, and geographic region, and by various combinations of all of these parameters.

User classes that are representative of the common business, government, institutional, and residential communities were selected. Traffic demand among these classes was distributed on the basis of employment, or, in the case of residential traffic, population. However, there is a considerable variation in the per employee traffic demand from user class to user class, and the model used for the distribution of traffic among the classes takes this into account. This is accomplished by weighting the employment estimates with user dependent activity factors, developed during the primary research survey. The activity factors vary from year to year, and from service subcategory to subcategory and, in effect, indicate the relative per employee demand for service of a given type emanating from each user class.

Because its activity factors and employment levels are both high, wholesale and retail trades generally account for the largest portion of demand, with the services and manufacturing user classes ranking second and third. Table 3 shows the relative CPS traffic demand by user class for the year 2000.

TABLE 3. BUSY HOUR CPS ADDRESSABLE TRAFFIC BY
USER CLASS - YEAR 2000

USER CLASS	PERCENT OF U.S. MARKET			
	VOICE	VIDEO	DATA	TOTAL TRAFFIC
MANUFACTURING	15	14	29	19
WHOLESALE & RETAIL TRADES	35	29	28	33
TRANSPORTATION AND UTILITIES	5	2	2	4
FINANCE, INSURANCE & REAL ESTATE	11	8	8	10
SERVICES	28	42	21	26
FEDERAL GOVERNMENT	3	2	8	5
STATE & LOCAL GOVERNMENTS	1	1	1	1
OTHER	2	2	3	2
TOTAL	100	100	100	100

The activity factors referred to above are also used in distributing demand among the nine geographic census regions. Those regions which contain higher concentrations of communications-intensive activities are apportioned correspondingly higher fractions of the total demand. Demand varies from year to year and from market to market but the East North Central region generally ranks first, followed closely by the South Atlantic, Pacific, and Mid Atlantic regions.

9.0 NATIONWIDE TRAFFIC DISTRIBUTION MODEL

Employment, weighted by the activity factors appropriate to each user class, is again used to distribute traffic among the SMSA and the non-SMSA areas of the United States. Demand for CPS traffic is estimated for each of the top 40 SMSAs and for the remaining SMSAs in groups of 20, as ranked in order of addressable busy hour traffic. The sum of the demand from all of the 264 SMSAs considered is subtracted from the U.S. total to arrive at estimates of demand originating in areas not included in the SMSAs. Table 4 shows the distribution of CPS addressable busy hour traffic projected for the year 2000. The top 20 SMSAs account for 35 percent of total U.S. demand. The top 40 SMSAs account for 48 percent, the top 60 account for 55 percent, and all of the 264 SMSAs together account for 78 percent of this traffic. The remaining 22 percent of traffic originates in smaller urban and rural areas outside the SMSAs.

TABLE 4. DISTRIBUTION OF YEAR 2000 U.S. CPS ADDRESSABLE TRAFFIC AND EARTH STATIONS BY SMSA RANK

SMSA RANK BY CPS TRAFFIC	% OF TRAFFIC	CUM. % OF TRAFFIC	NUMBER OF DEDICATED E.S.	NUMBER OF SHARED & DEDICATED E.S.
1-20	34.70	34.70	667	1471
21-40	12.88	47.58	248	546
41-60	7.62	55.20	146	323
61-80	4.98	60.18	96	211
81-100	3.96	64.14	76	168
101-120	3.18	67.32	61	135
121-140	2.59	69.91	50	110
141-160	2.03	71.94	39	86
161-180	1.65	73.59	32	70
181-200	1.42	75.01	27	60
201-220	1.23	76.24	24	52
221-240	1.04	77.28	20	44
241-260	.83	78.11	16	35
261-264	.12	78.23	2	5
NON SMSA	21.75	100.00	418	922
TOTAL U.S.	-	-	1922	4239

Table 4 also summarizes the distribution of CPS earth stations among the SMSAs. These projections are based on estimates of the number of establishments nationwide which meet the employment size criteria considered appropriate for the installation of earth stations. About 1900 dedicated, and 2300 shared, earth stations are projected for the U.S. in the year 2000. The number of earth stations projected for the U.S. are then distributed among the individual SMSAs in proportion to each SMSA's fraction of the total busy hour traffic. Using this approach, in the year 2000, the Los Angeles-Long Beach SMSA is found to rank first, with a total of 182 shared and dedicated earth stations. The New York and Chicago SMSAs rank second and third with 164 and 144 shared and dedicated earth stations, respectively.

As part of the nationwide traffic distribution model the year 2000 busy hour CPS traffic between pairs of SMSAs is projected for the top 40 SMSAs. Results are presented as a matrix showing the fraction of CPS traffic that originates in each of these SMSAs that is destined for each of the other SMSAs and for the areas not included in the SMSAs.

The CPS-equipped community is expected to be relatively compact, encompassing some 21 percent of U.S. employment. However, many important telecommunications applications require wide distribution to establishments outside of, as well as within, the CPS community. As discussed earlier, interfaces between CPS and trunking facilities are, therefore, of importance in allowing CPS systems to address the widest possible market. It is estimated that these interfaces will require capacity in the range of 50 to 80 percent of the CPS-originated traffic arriving at an SMSA.